Threats to the Federally Threatened Pitcher's Thistle in Indiana: Management Implications

Noel B. Pavlovic*, A. Kathryn McEachern, Kay Havens, Jeremie B. Fant, Marlin L. Bowles, Tim J. Bell, and Claudia L. Jolls

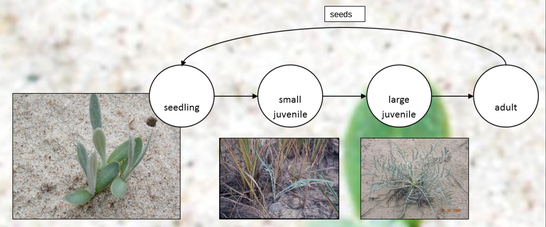
Abstract:

Pitcher's thistle (*Cirsium pitcheri*) is a federally threatened plant of the coastal dunes of the western Great Lakes. Twenty four years of demographic monitoring suggests that this species is declining in the southern limits of its range. On October 17, 2011, a one day workshop was held at the Dunes State Park to discuss Pitcher's thistle research results and explore strategies for management. Multiple threats to Pitcher's thistle include drought, habitat succession, seed consumption by weevils, seed predation by goldfinches, inbreeding, trampling, and changing climate, We present the general results of this workshop summarizing research findings and required management actions needed to ensure population viability. Ongoing research examining the impacts of goldfinch seed predation and Insect herbivory on Pitcher's thistle will be discussed in this context.

Introduction:

Pitcher's thistle is endemic to the coastal sand dunes of the western Great Lakes (Illinois, Indiana, Michigan, Ontario, Wisconsin). It is listed by the US Fish and Wildlife Service as threatened. It is a monocarpic perennial that lives for 3 to 8 years before flowering, setting seed, and dying. This species grows from the beach, into the foredunes and further inland in secondary dunes in blowouts. It prefers habitats that have greater than 50% bare ground. The most viable populations occur on continuous landscapes or perched dunes, mostly in the northern part of the range.

The Indiana populations of Pitcher's thistle are at the southern limit of its range, primarily growing in blowouts. It has largely been extirpated from foredunes due to shoreline erosion and human impacts on the beach and foredunes.



Demography (Pavlovic and McEachern)

Since 1988, we have been monitoring patches of Pitcher's thistle in tenth hectare circular plots at Miller High Dunes and West Beach at the Indiana Dunes National Lakeshore (INDU), and at the Big Blowout in the Dunes State Park (DSP). Populations have declined significantly at West Beach and Big Blowout but have recently increased at Miller High Dunes (Figure 1). Since Pitcher's thistle migrates throughout the non-forested landscape in time, as a metapopulation, these plots do not represent the abundance of Pitcher's thistle on the landscape, except at Miller High Dunes where to plot includes all plants.

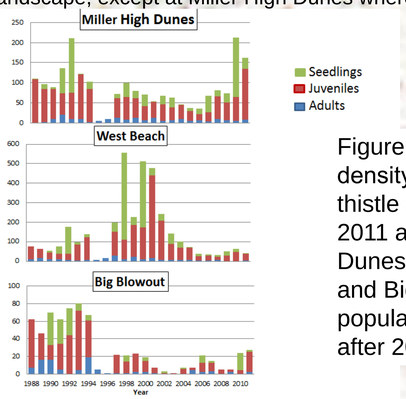


Figure 1. Changes in density of Pitcher's thistle from 1988 to 2011 at Miller High Dunes, West Beach, and Big Blowout. All populations declined after 2005 drought.

Metapopulations (Pavlovic and McEachern)

We have found that Pitcher's thistle does migrate in the open dunes landscape in time (Figure 2). At the landscape scale, Pitcher's thistle appears to be declining in absolute numbers of plants. From 1991 to 2008, there has been a 70.9% decline in Pitcher's thistle numbers at Big Blowout (Table 1). The temporal changes in population differed between the interior and nearshore portions of the blowout. We hypothesize that these declines area a result of increasing drought frequency and other possible factors such as goldfinch seed predation.

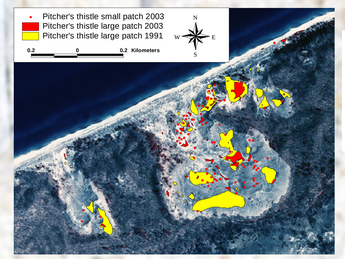


Figure 2. Metapopulation dynamics at Big Blowout (DSP) illustrated by temporal shifting of patches.

Table 1. Numbers of Pitcher's thistle patches and plants from 1991, 2003, and 2008 at Big Blowout, Dunes State Park.

	Interior			Nearshore		
Year	**1991**	**2003**	**2008**	**1991**	**2003**	**2008**
Patches (N)	**16**	**39**	**42**	**9**	**48**	**25**
Plants (N)	**517**	**294**	**160**	**340**	**591**	**163**
% change		**-43.1**	**-45.6**		**173.8**	**-72.4**

Population Viability (Bell, Bowles, and Jolls)

Matrix projection analysis indicated that all INDU populations had a low probability of persisting for 100 years (Table 2). The beach grass restoration site (AMBR) at Ogden Dunes East was the only population to have a lambda greater than one, indicating positive population growth. The impact of threats to viability of Pitcher's thsitle are shown in Figure 3).

Table 2. Population statistics from matrix projection modeling of Pitcher's thistle at West Beach (WEBE), Miller High Dunes (MIHI), Big Blowout (SPBB). Restoration sites are Little Bluestem (ANSC) and Beach grass (AMBR) at INDU near Ogden Dunes.

Site	Name	λ_s	95% bootstrap CI for λ_s	Chance to persist to 100 years	Median time to extinction (years)
WEBE	Indiana Dunes National Lakeshore – West beach	0.8253	(0.7782, 0.8810)	0% (0%, 0%)	15.4 (12,22)
MIHI	Indiana Dunes National Lakeshore – Miller	0.8876	(0.8351, 0.9428)	0.91% (0%, 8.20%	26.4 (18, 42)
SPBB	Indiana Dunes National Lakeshore – Big Blowout	0.9138	(0.8320, 0.9947)	4.59% (0%, 51.80%)	21.6 (10, 47)
ANSC	Indiana Dunes National Lakeshore – Ogden Dunes W	0.6394	(0.5489, 0.7313)	0% (0%, 0%)	8.6 (7,12)
AMBR	Indiana Dunes National Lakeshore – Ogden Dunes E	1.0029	(0.8818, 1.1436)	56.86% (0%, 1%)	19 (10, 100)

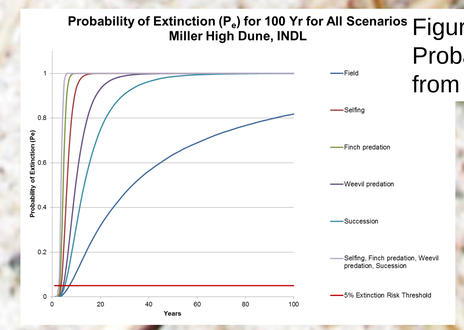


Figure 3. Impacts of threats on population Probability of extinction based on models from Miller High Dunes.

Population Genetics (Fant and Havens)

Populations at Indiana Dunes (yellow triangles in Figure 4) showed low alleles per loci, low genetic diversity, and high inbreeding. Population size ranges from 1 = high (N > 10,000) to 5 = low (N < 100). The relationships between size and allelic and genetic diversity are significant.

Threats to Pitcher's thistle

Trampling
Erosion
Burial
Inbreeding
Rabbit grazing
Competition
Climate
Insect feeding
Goldfinch seed predation

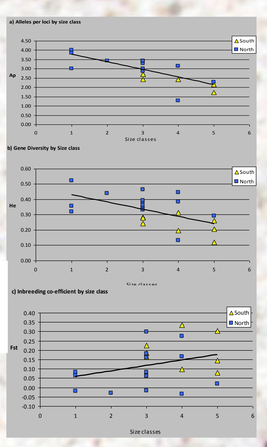


Figure 4. Population size classes versus genetic variables.

Emerging Threats

Since 2008, we have noticed evidence that goldfinches have been predating seeds to an estimated level of approximately 90%. This estimate is based on cracked seeds found at the base of adult plants (Figure 5). We are now investigating goldfinch seed predation and whether seed head bagging can be a suitable method to mitigate these high loses of seeds.

Figure 5. Photographs of goldfinch cracked seeds at base of adult plant, goldfinch damage to flower, and experimental bridal veil net to exclude goldfinches.

Of the two biocontrol insects, that have transferred to Pitcher's thistle, we have found *Rhinocyllus conicus* in Pitcher's thistle heads at Keiser Blowout, Big Blowout, and Miller High Dunes, but not at West Beach, Howes Prairie, and the Ogden Dunes restoration sites(Figure 6). *R. conicus* was introduced to control musk thistle (*Carduus nutans*). These weevils damage developing seeds.

Figure 6. *R. conicus* (left) and two adults imbedded in receptacle (right).

Conclusions:

Pitcher's thistle at the Indiana Dunes is declining as a result of droughts, seed predation by goldfinches, herbivory on seeds by weevils, low genetic diversity, inbreeding depression, and other factors.

Management Implications:

1. To increase genetic variability and reduce inbreeding depression populations need introductions of seed from other sites.
1. To increase connectivity between populations, restoration by introduction of new patches will be needed.
2. To boost existing populations, common gardens will be needed to increase seed production for use in restoration..
3. Minimize goldfinch seed predation through netting application, seed collection and replanting in situ.
4. How do we control weevil infestation.

* Lake Michigan Ecological Research Station, 1100 N. Mineral Springs Rd., Porter, IN 46304, 219-926-8336 X 428, npavlovic@usgs.gov